NASA Origins Program

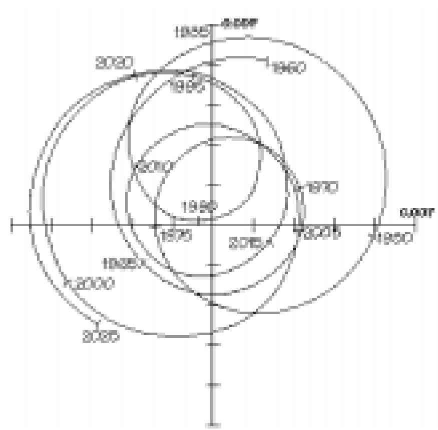
Palomar Testbed Interferometer

The NASA-JPL Palomar Testbed Interferometer as seen from the Catwalk of the 200” Hale Telescope at Palomar Observatory, CA

PTI Technical Description

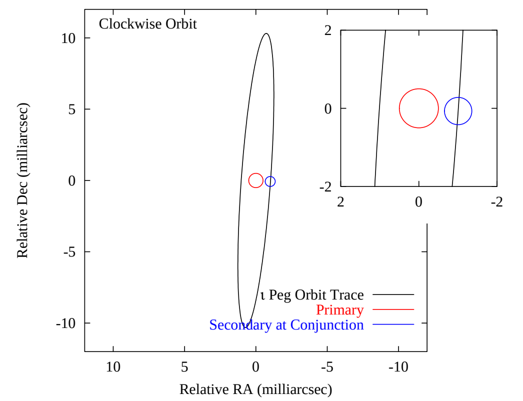
The Palomar Testbed Interferometer (PTI) is a near-infrared (K-band, 2 -- 2.4 micron), long-baseline (110 meters or 360 feet) stellar interferometer located at Palomar Observatory. This interferometer uses multiple telescopes to measure interference fringes created when light gathered by the telescopes is combined and processed. This technique enables scientists to measure the positions and distances between stars with great accuracy. PTI was conceived, designed, and constructed primarily as an engineering facility to demonstrate ground-based differential astrometry. Differential astrometry, the measurement of the relative angular separations of stars on the sky, is a technique to detect planetary-mass companions to nearby stars by their gravitational influence. By virtue of its long interferometric baseline, PTI will demonstrate the very accurate astrometric measurements necessary to infer the presence of planets around nearby stars. This differential astrometry objective motivates both the operation in the near infrared, and PTI's unique dual-star feed design that allows it to track starlight interference fringes on two stars simultaneously. PTI's dual star feed system is the first of its kind, and astrometric operation is a necessary technical demonstration for the NASA Origins Program's Keck Interferometer.

PTI was developed for NASA by the Jet Propulsion Laboratory, California Institute of Technology. PTI saw first fringes on the primary beam combiner in July 1995, and fringes on two separate stars in November 1995. Since that time PTI has been undergoing engineering improvements to perform both differential



The wobble in the position of our sun due to the influence of the planets in our Solar system, as it would be seen from approx. 30 light-years away.

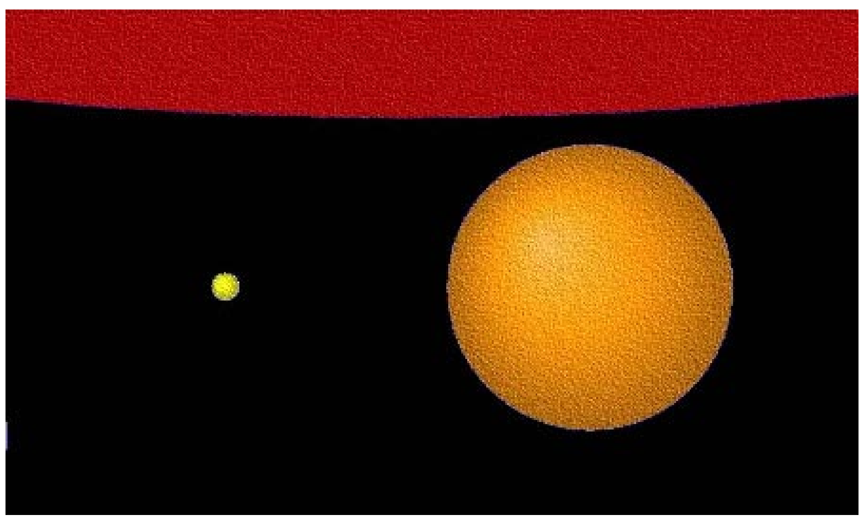
astrometry and fringe amplitude measurements. PTI has also been used in a number of scientific investigations such as giant star diameter measurements and binary star orbit measurements (see below).



Visual Orbit of the Binary Star Iota Pegasi

Interference Fringe Amplitude Science

In addition to dual-star astrometry engineering, PTI has been used to make scientific observations of giant stars and binary stars using fringe amplitude measurements. One example of a binary star orbit measured by PTI is shown here. The well-known binary Iota Pegasi in the constellation Pegasus is a nearby (approximately 40 light-years), short period (10 days) binary star system comprised of two young stars roughly similar to our Sun. The separation of the two stars is roughly 1/10 of the Sun-Earth separation, and they travel in circular orbit relative to each other, which appears highly elliptical because of our viewing geometry from the Earth. At the distance to Iota Peg the apparent separation of these two stars on the sky is roughly 3 one millionths of one degree. This apparent separation makes Iota Pegasi appear as a single star to conventional telescopes, but PTI easily resolves the system into two separate components. By measuring the apparent orbit of the two stars and combining that with existing spectroscopic information we can accurately measure many of the fundamental properties (mass, size, luminosity) of these two stars.



Relative Dimensions of Giant and Supergiant Stars Measured With PTI. Our yellow sun is 10 times smaller than the yellow-orange giant Delta Boötis, and more than 300 times smaller than the red supergiant Xi Cygni

Another topic PTI has considered is the physical diameters of giant and supergiant stars in the final phases of their life cycle. The giant stars are in an evolutionary stage one step further along from our sun; rather than fusing hydrogen into helium to produce energy, their hydrogen-depleted cores are fusing the helium “ash” into even heavier elements, such as carbon, nitrogen and oxygen. The supergiant stars are one step further along than even the giant stars; their cores are fusing these elements into even heavier iron. The most massive of the supergiants will eventually explode in catastrophic supernova explosions, littering the cosmos with heavy elements.